FIG. 1

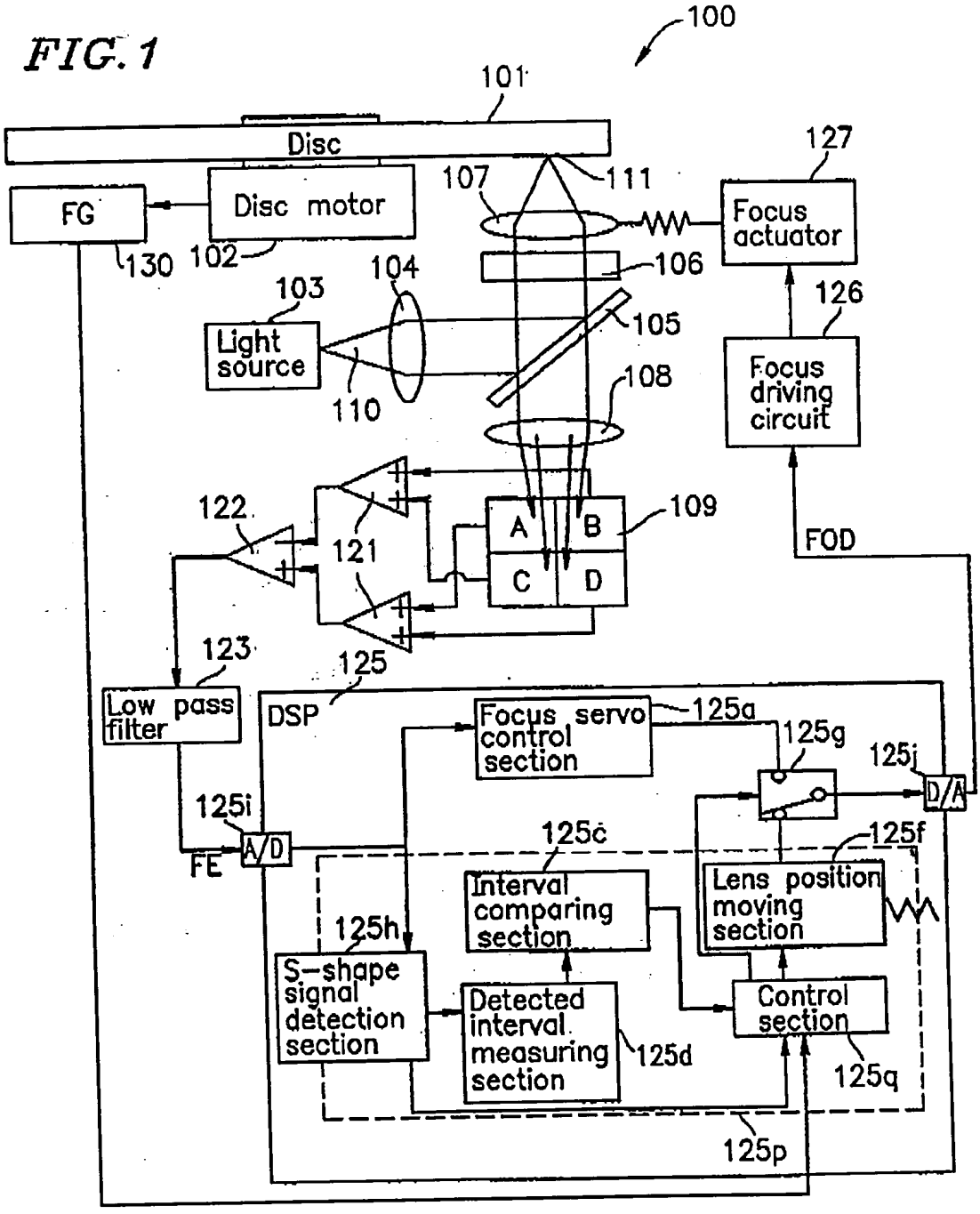
100
101
Disc
FG
Disc motor
130
102
107
111
127
Focus actuator
106
103
104
105
Light source
110
108
126
Focus driving circuit
122
121
A
B
C
D
109
FOD
123
125
Low pass filter
DSP
Focus servo control section
125a
125g
125j
D/A
125i
A/D
FE
125c
125f
Interval comparing section
Lens position moving section
125h
S-shape signal detection section
Detected interval measuring section
125d
Control section
125q
125p

FIG. 2

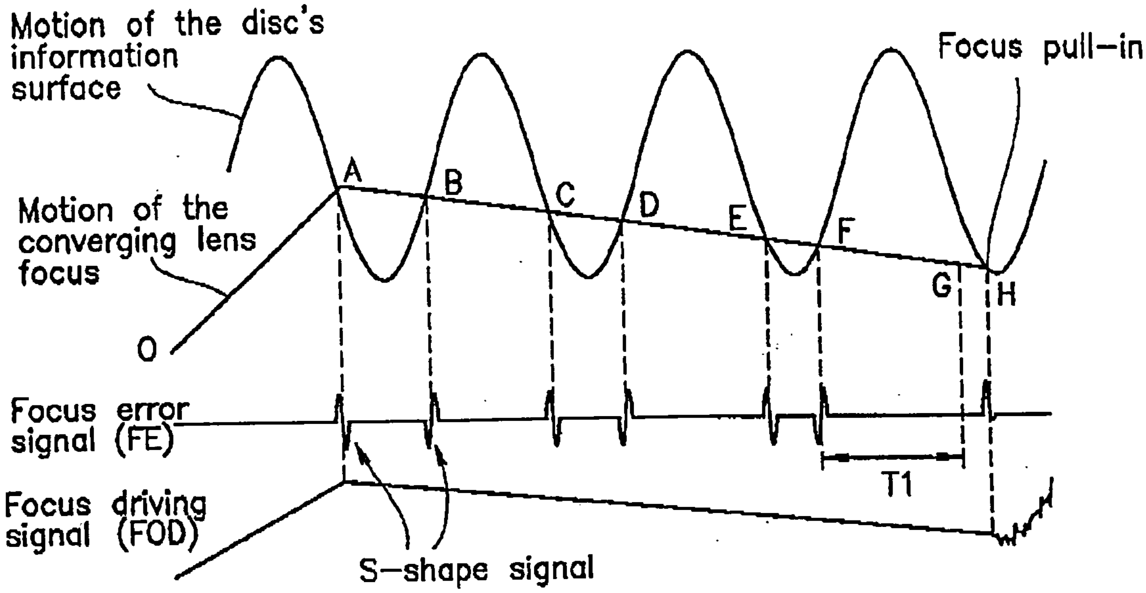

FIG. 3

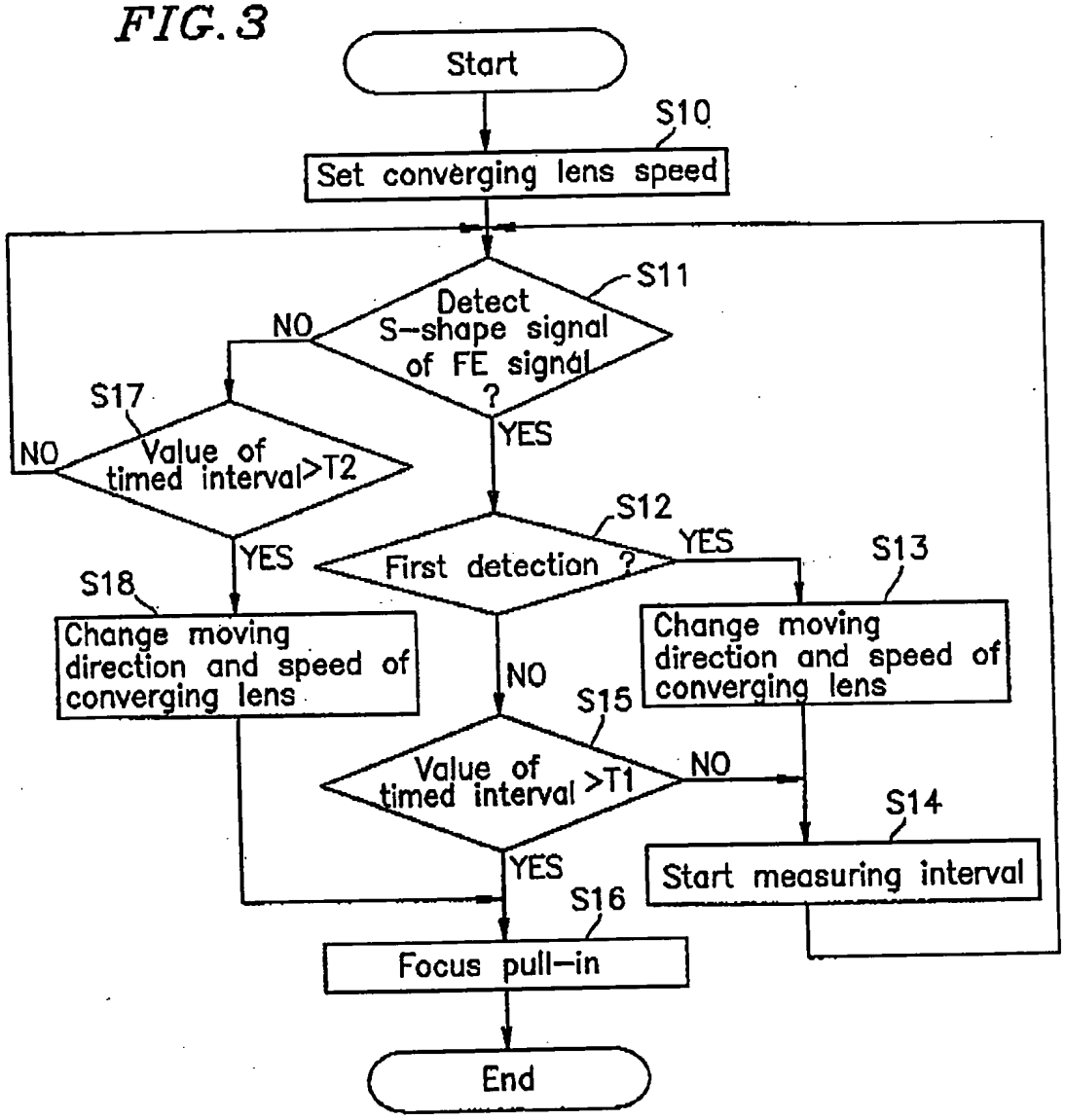
Start
S10
Set converging lens speed
S11
Detect S-shape signal of FE signal ?
NO
YES
S17
Value of timed interval>T2
NO
YES
S12
First detection ?
YES
S13
S18
Change moving direction and speed of converging lens
Change moving direction and speed of converging lens
NO
S15
Value of timed interval >T1
NO
S14
Start measuring interval
YES
S16
Focus pull-in
End

FIG. 4

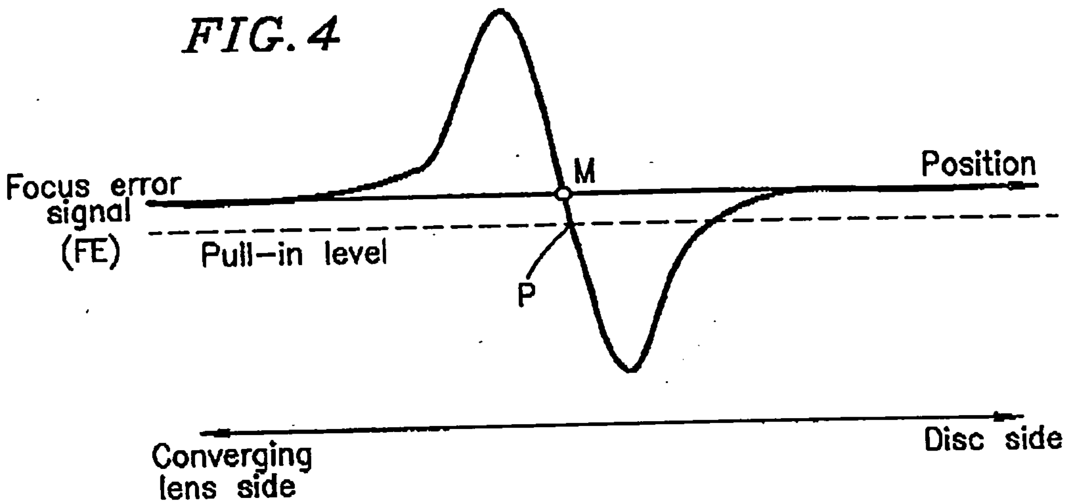
Focus error signal (FE)
Pull-in level
M
P
Position
Converging lens side
Disc side

FIG. 5

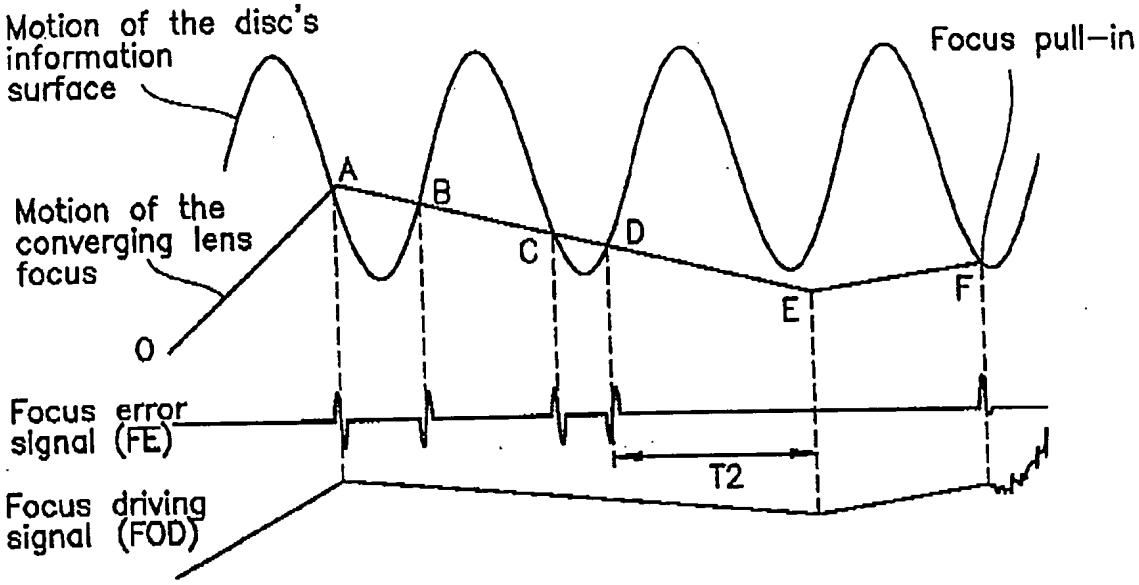
Motion of the disc's information surface
Focus pull-in
A
B
C
D
E
F
Motion of the converging lens focus
0
Focus error signal (FE)
T2
Focus driving signal (FOD)

FIG. 6

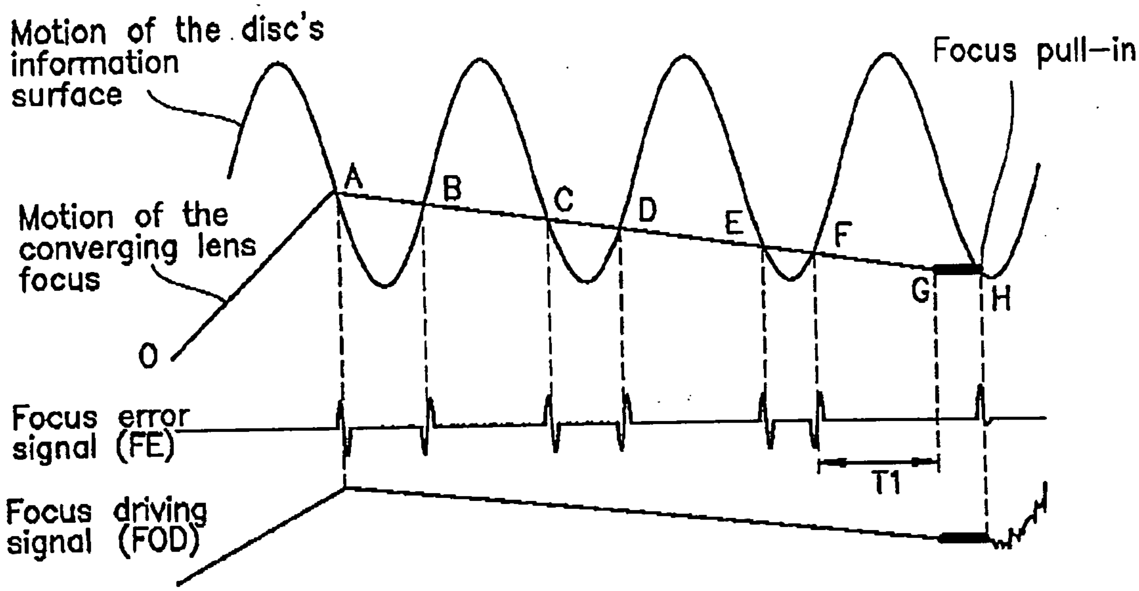
Motion of the disc's information surface
Focus pull-in
Motion of the converging lens focus
A
B
C
D
E
F
G
H
0
Focus error signal (FE)
T1
Focus driving signal (FOD)

FIG. 7

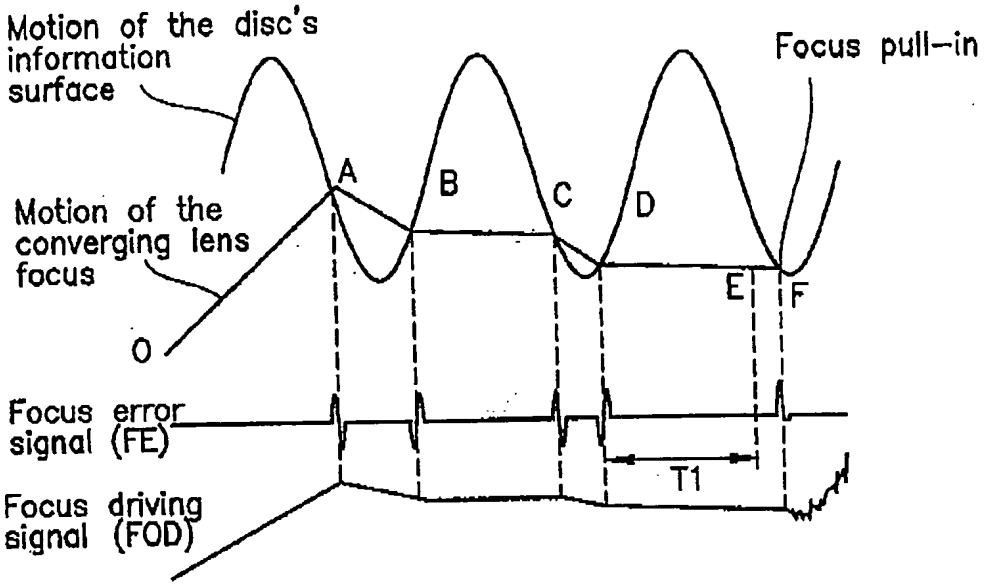
Motion of the disc's information surface
Focus pull-in
A
B
C
D
E
F
Motion of the converging lens focus
O
Focus error signal (FE)
T1
Focus driving signal (FOD)

FIG. 8

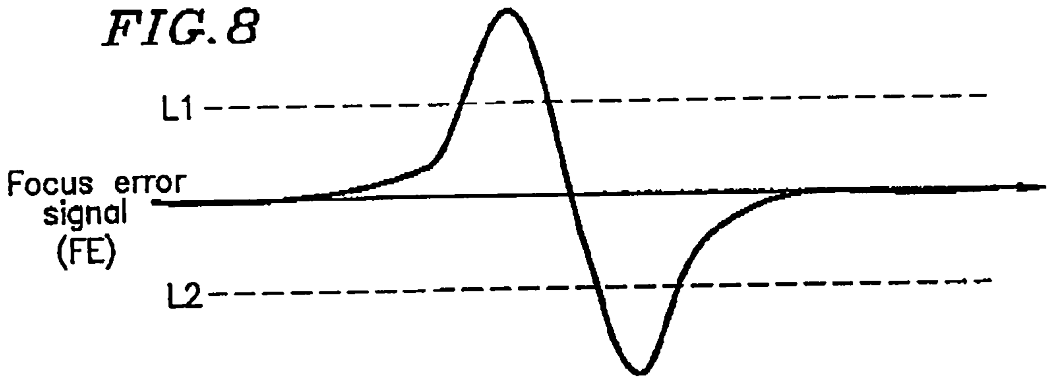

FIG. 9

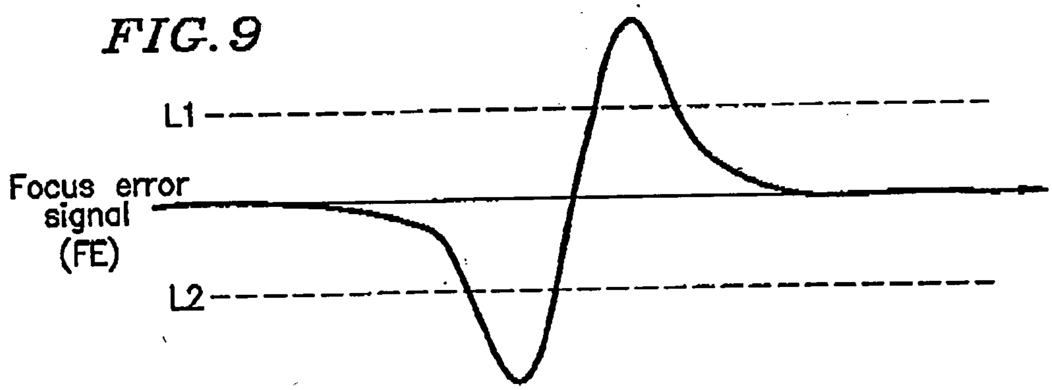

FIG. 10

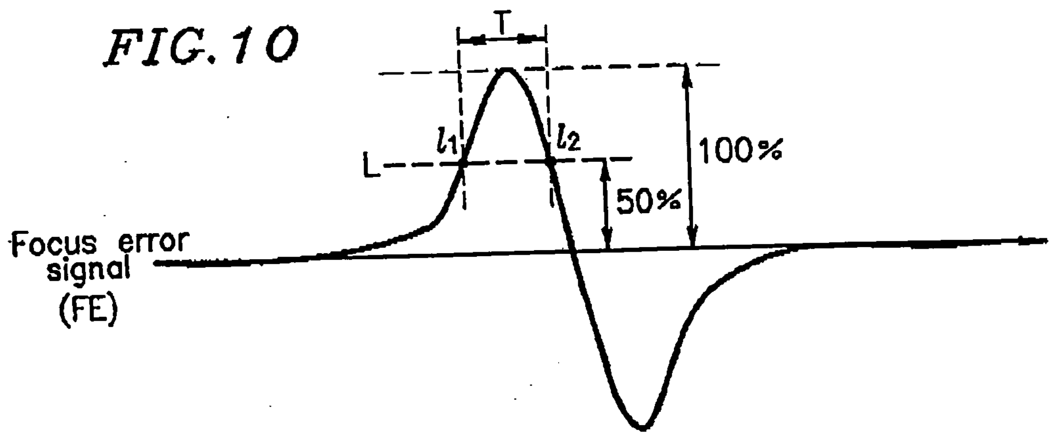

FIG. 11

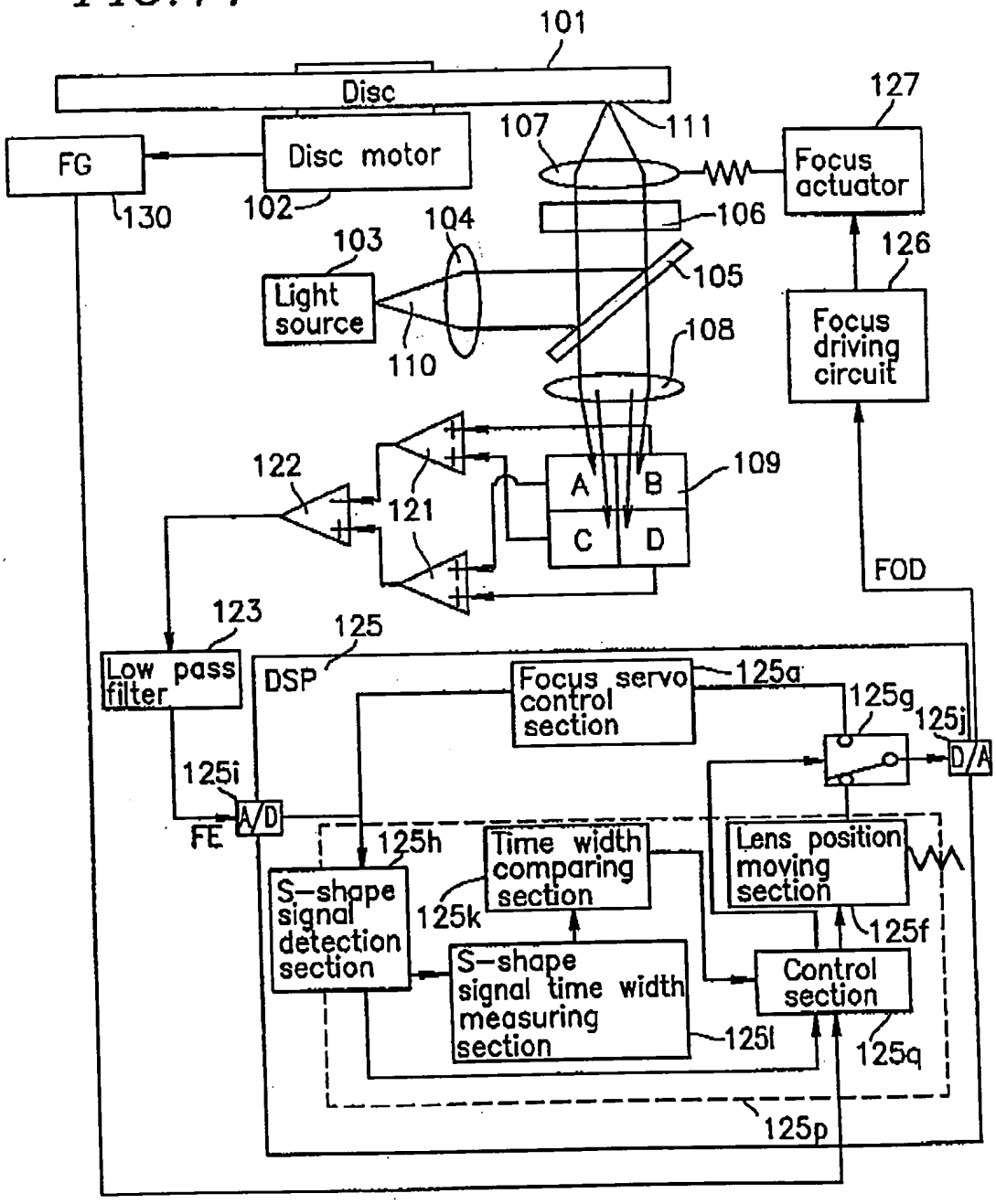
101
Disc
127
107
111
FG
Disc motor
Focus actuator
130
102
106
103
104
126
Light source
105
Focus driving circuit
110
108
122
121
A
B
109
C
D
FOD
123
125
Low pass filter
DSP
Focus servo control section
125a
125g
125j
D/A
125i
A/D
FE
125h
Time width comparing section
Lens position moving section
S-shape signal detection section
125k
125f
S-shape signal time width measuring section
Control section
125l
125q
125p

FIG. 12

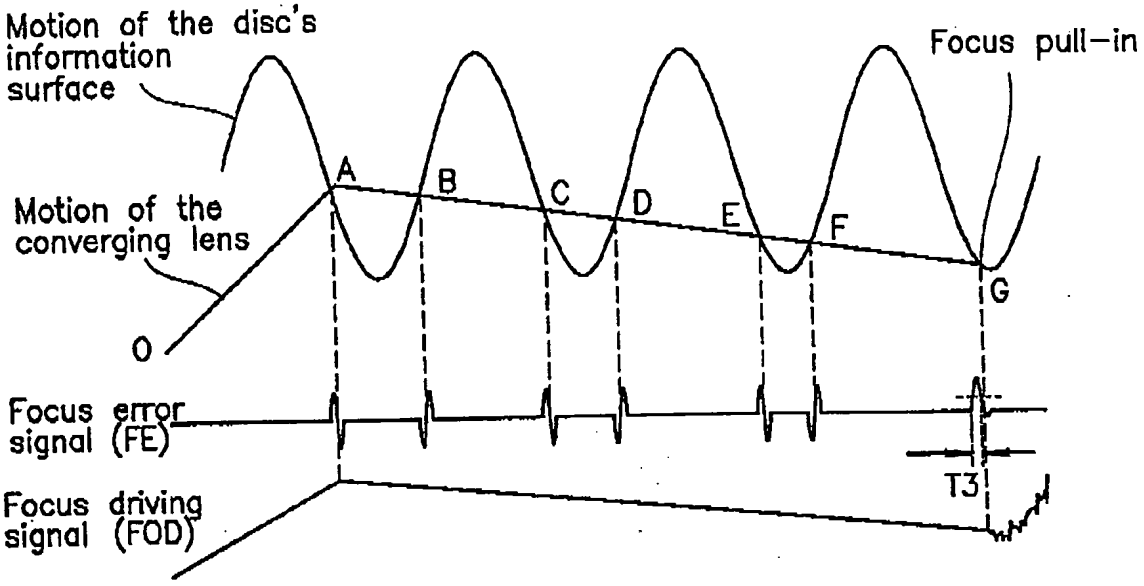
Motion of the disc's information surface
Focus pull-in
A
B
C
D
E
F
G
Motion of the converging lens
0
Focus error signal (FE)
T3
Focus driving signal (FOD)

FIG. 13

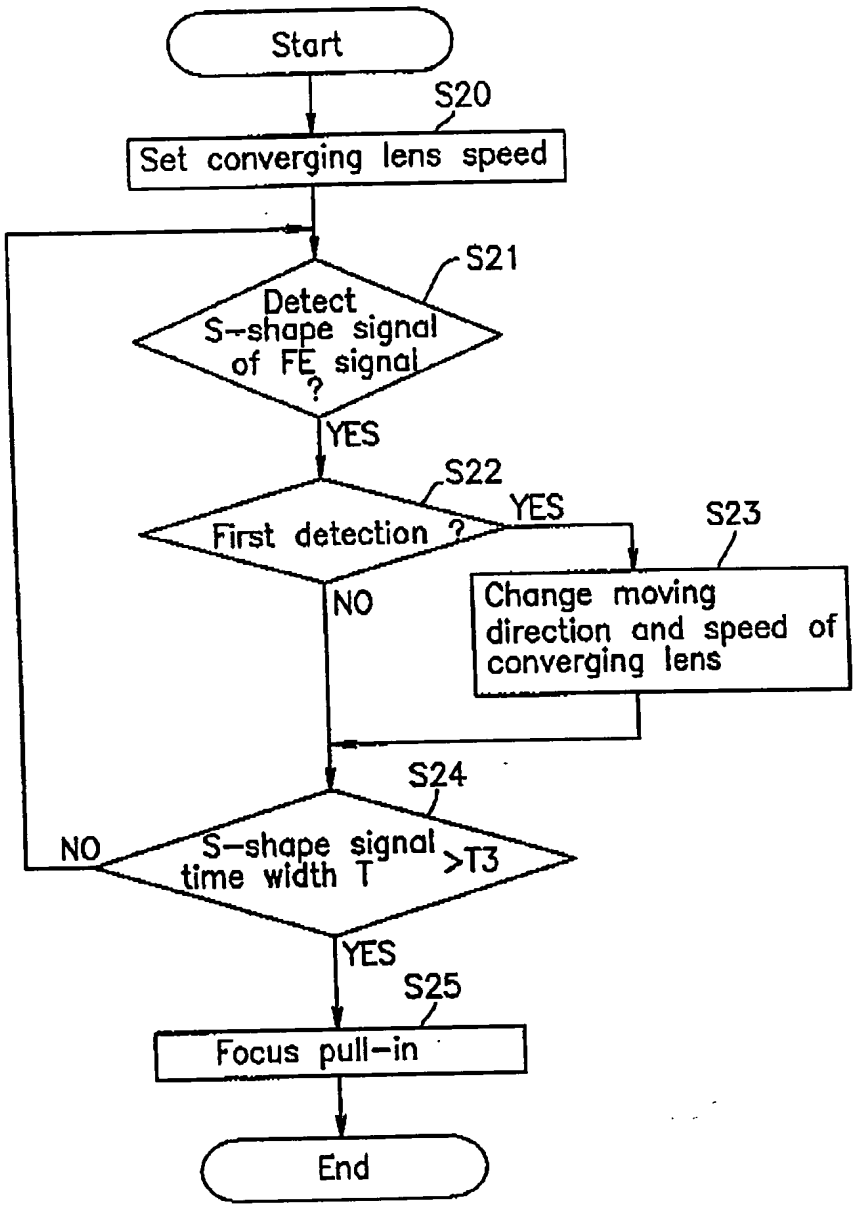
Start
S20
Set converging lens speed
S21
Detect S-shape signal of FE signal ?
YES
S22
First detection ?
YES
S23
Change moving direction and speed of converging lens
NO
S24
S-shape signal time width T >T3
NO
YES
S25
Focus pull-in
End

FIG. 14

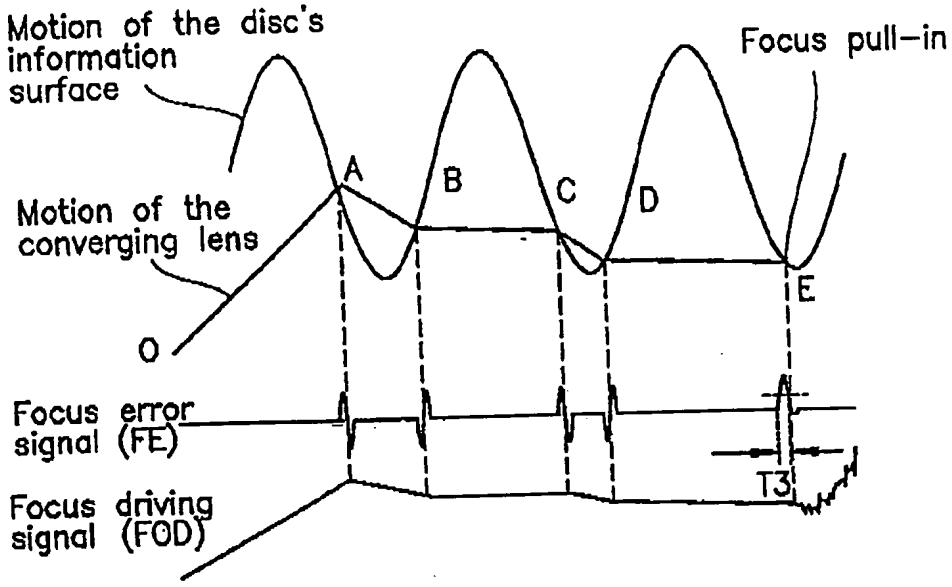
Motion of the disc's information surface
Focus pull-in
A
B
C
D
E
Motion of the converging lens
0
Focus error signal (FE)
T3
Focus driving signal (FOD)

FIG. 15

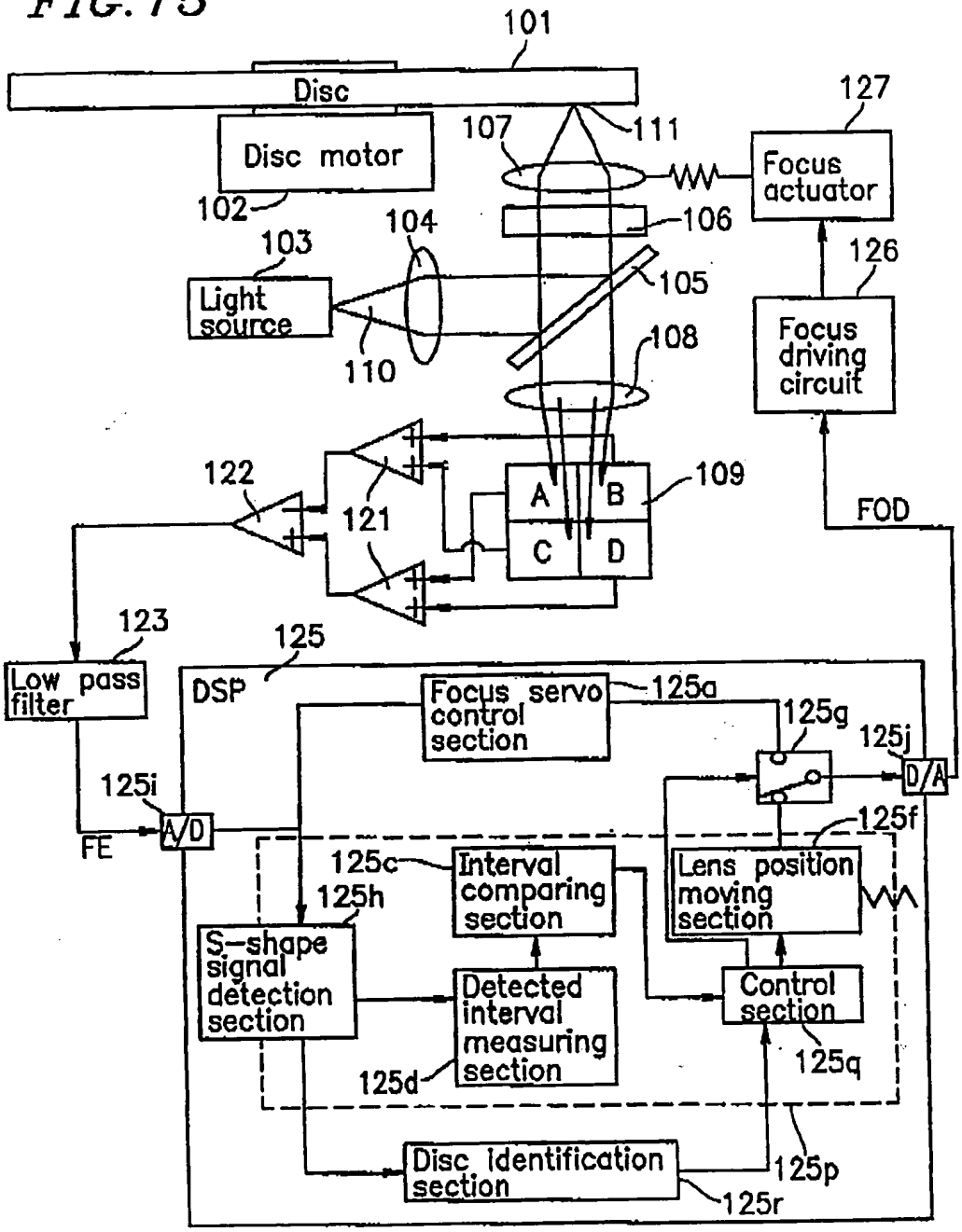
101
Disc
127
107
111
Disc motor
Focus actuator
102
106
104
103
126
105
Light source
Focus driving circuit
110
108
122
121
A
B
109
C
D
FOD
123
125
Low pass filter
DSP
Focus servo control section
125a
125g
125j
D/A
125i
A/D
FE
125f
125c
Interval comparing section
Lens position moving section
125h
S-shape signal detection section
Detected interval measuring section
Control section
125d
125q
Disc identification section
125p
125r

FIG.16A

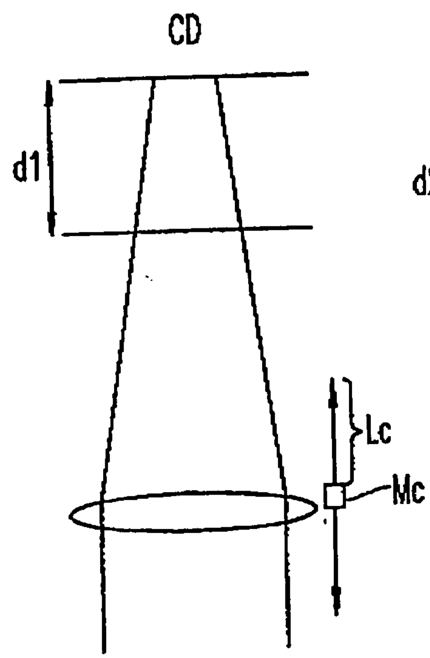

FIG.16B

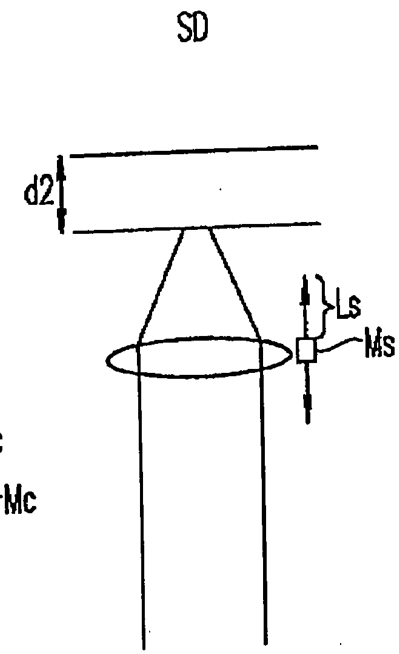

FIG.16C

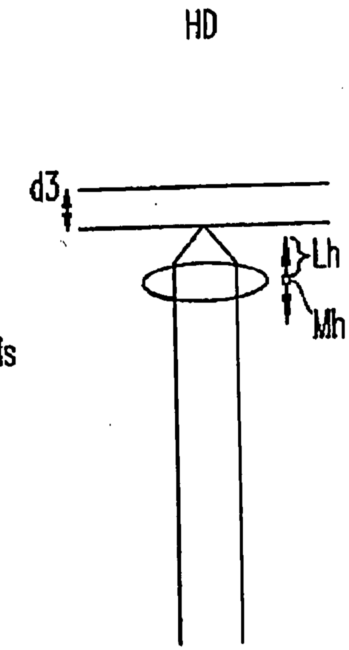

FIG. 17

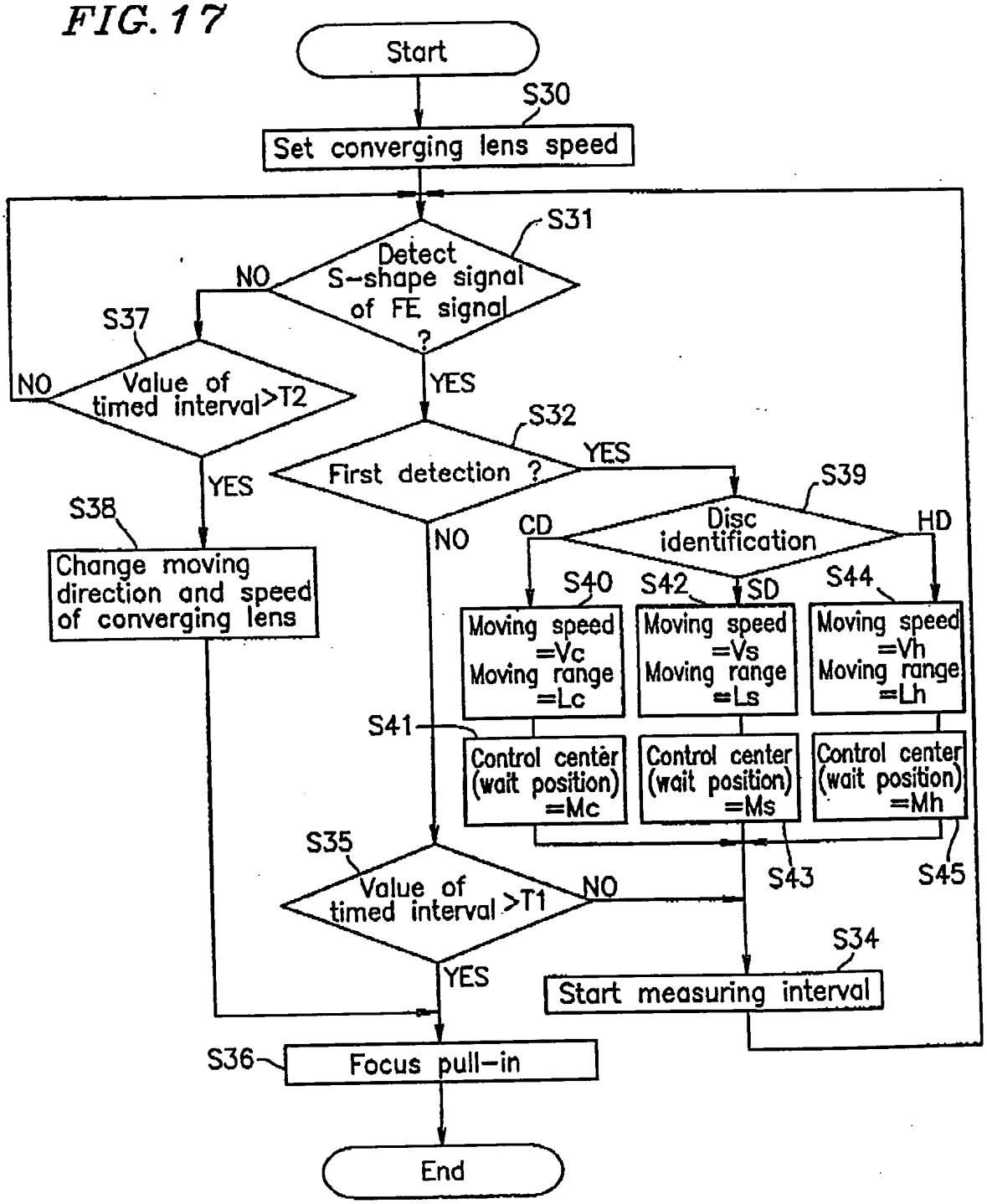
Start
S30
Set converging lens speed
S31
Detect S-shape signal of FE signal ?
NO
YES
S37
Value of timed interval>T2
NO
YES
S32
First detection ?
YES
NO
S38
Change moving direction and speed of converging lens
S39
Disc identification
CD
SD
HD
S40
Moving speed =Vc
Moving range =Lc
S42
Moving speed =Vs
Moving range =Ls
S44
Moving speed =Vh
Moving range =Lh
S41
Control center (wait position) =Mc
Control center (wait position) =Ms
Control center (wait position) =Mh
S43
S45
S35
Value of timed interval >T1
NO
YES
S34
Start measuring interval
S36
Focus pull-in
End

FIG. 18

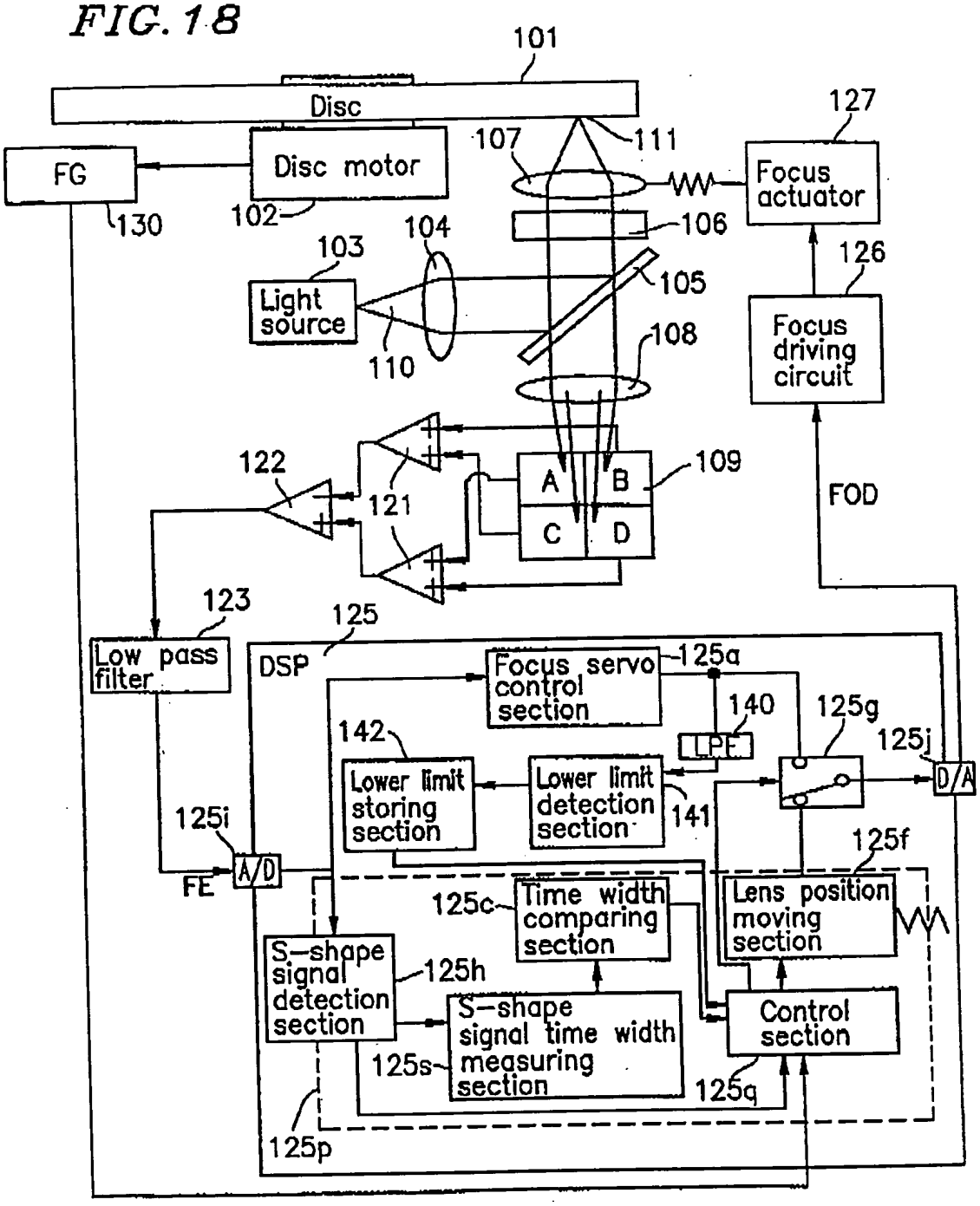
101
Disc
127
107
111
FG
Disc motor
Focus actuator
130
102
106
103
104
126
Light source
105
Focus driving circuit
110
108
122
121
A
B
109
C
D
FOD
123
125
Low pass filter
DSP
Focus servo control section
125a
140
125g
142
LPF
125j
Lower limit storing section
Lower limit detection section
141
D/A
125i
A/D
FE
125f
125c
Time width comparing section
Lens position moving section
S-shape signal detection section
125h
S-shape signal time width measuring section
Control section
125s
125q
125p

FIG. 19A

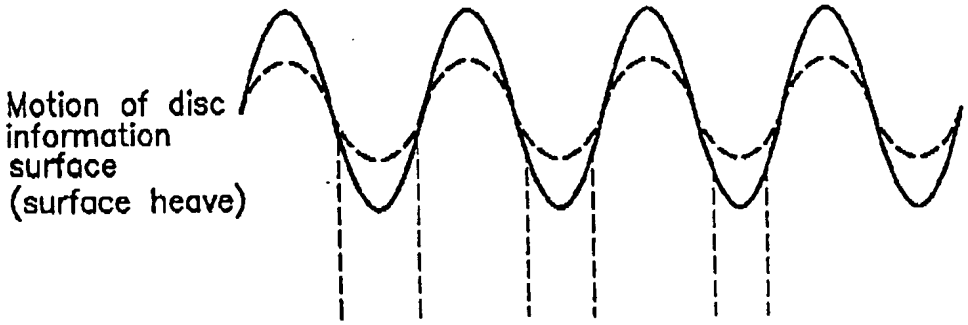

FIG. 19B

FIG. 19C

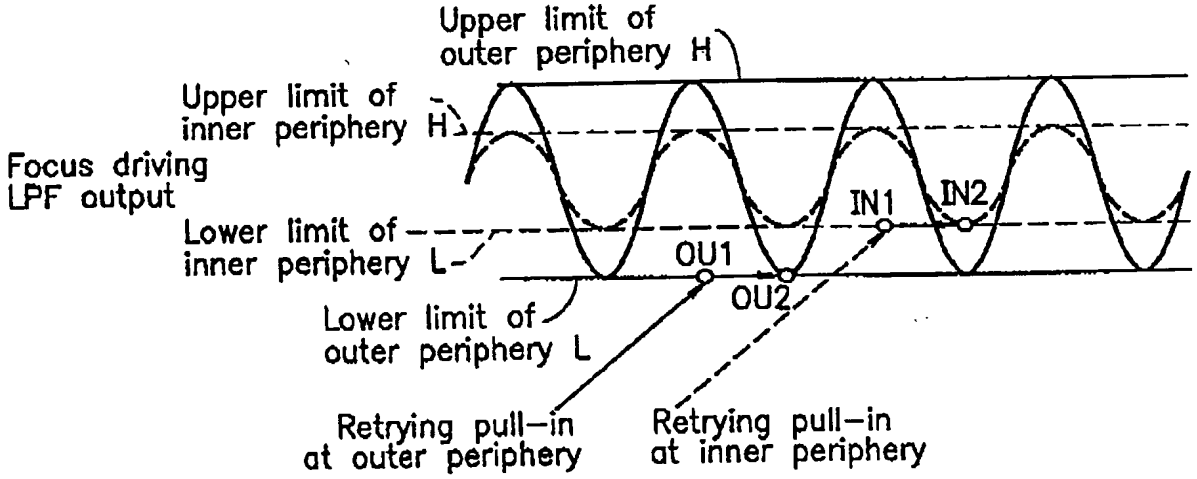

FIG. 20

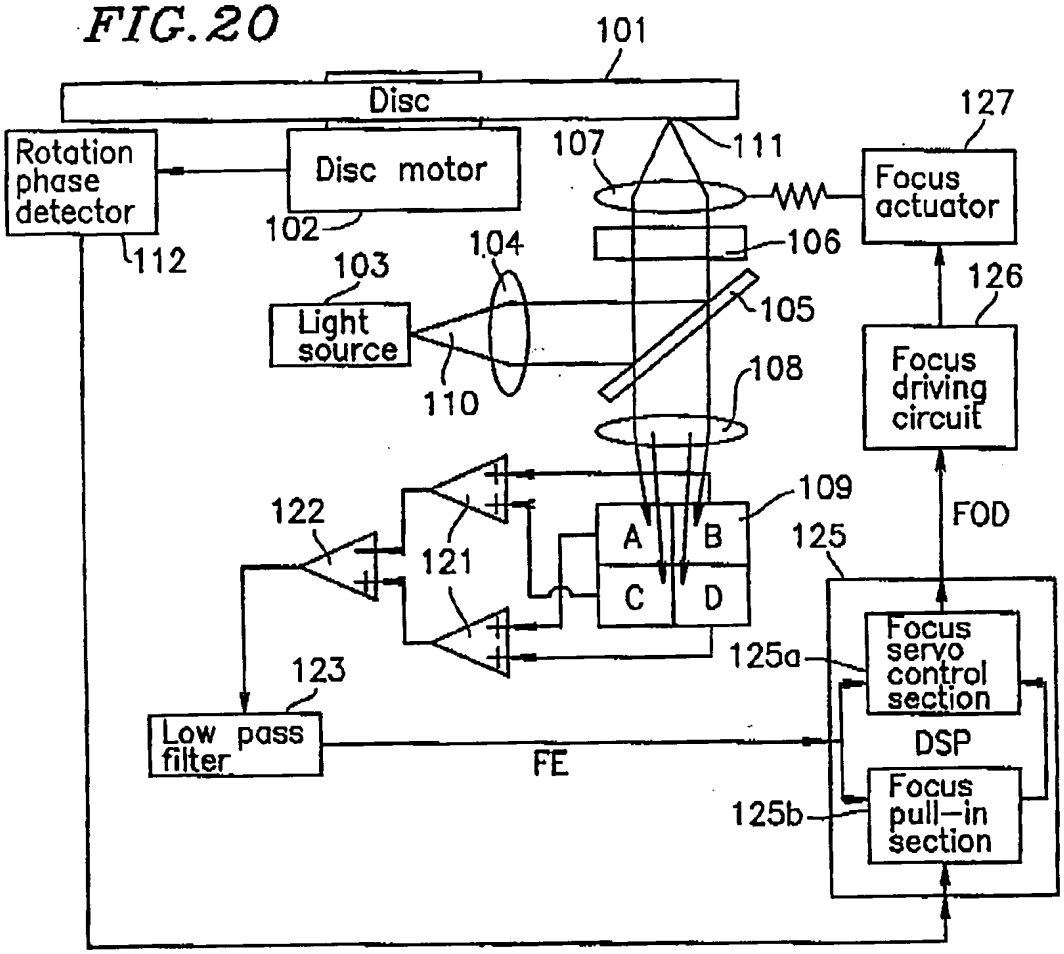
101
Disc
127
Rotation phase detector
Disc motor
107
111
Focus actuator
112
102
104
106
103
126
Light source
105
Focus driving circuit
110
108
109
122
FOD
A
B
121
125
C
D
Focus servo control section
125a
123
Low pass filter
FE
DSP
Focus pull-in section
125b

FIG.21